Vitamins A, C and Lycopene Contents of Some Varieties of Tomato and Pepper in the Southwest Region of Nigeria

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Abstract

The concentrations of vitamin A, C and lycopene were determined in some varieties of *Lycopersicum esculentum* (Plum tomato, Marmande tomato, Beefsteak tomato and Cherry tomato) and *capsicum sp.* (fresh Cayenne pepper, Bell pepper, Green pepper, Sweet pepper, Hot pepper and Dry cayenne pepper). The ethanolic extracts of the varieties of tomato and pepper were prepared and the vitamin A and lycopene contents were quantified by separating funnel technique, while the concentration of vitamin C was determined by titration technique in the aqueous extract. The concentrations of vitamin A and lycopene were significantly increased ($p<0.05$) in Plum and Cherry tomatoes. Vitamin A concentration in the various pepper fruits increased significantly ($p<0.05$) in the order: green pepper<sweet pepper=hot pepper<bell pepper< dry cayenne<cayenne. Significant increases ($p<0.05$) were presented only in the Vitamin C contents in the green, hot and cayenne pepper fruits with no changes ($p>0.05$) among these pepper. Lycopene concentrations were significant increased ($p<0.05$) in the order of green pepper<sweet pepper<bell pepper<cayenne pepper. The finding of the study indicated that the Plum and Cherry tomato fruits, and Bells and fresh Cayenne pepper fruits would have better anti-oxidative capabilities. Therefore, the consumption of the combination of these tomato and pepper fruits as recipes in soup or stew making may boost the endogenous anti-oxidative status.

Keywords: *Lycopersicum esculentum*, *capsicum species*, Vitamin A, Vitamin C, Lycopene, anti-oxidative capabilities, recipes and boost the anti-oxidative status.

1. Introduction

Fruits and vegetables are of great nutritional value. They are important sources of vitamins and minerals, thus, essential components of human diet (Egharevba, 1995). Vegetables are important in the human diets since they contain carbohydrates, proteins, as well as vitamins, minerals and trace elements (Dastane, 1987). Regular intake of vegetable food is indispensable for good health, fitness and the feeling of well–being. In addition, millions of people throughout the developing countries of the world were reported to have inadequate food supply or have nutrient deficiencies in their diets, which led to problems due to starvation and malnutrition of various types (NAS, 2004). Thus, there has been an increase in the awareness on the food value of vegetables, as a result of exposure to other cultures and acquiring proper food education (Fisseha, 2002).

Tomato (*Lycopersicon esculentum Mill*), is a major renowned source of minerals, vitamins and health acids. It is one of the most important vegetable crops of the *Solanaceae* that is grown universally (FAOSTAT, 2005). The fact that tomato belongs to the '*nightshade*' plant family, resulted the Latin name, *Lycopersicon*. Lycopersicum, which literally means "wolf peach" was the name given to the tomato plant and was responsible for the false toxic reputation of the fruit. However, in the actual fact, it is the tomato leaf that is toxic and not the tomato fruit. There are quite a number of tomato varieties and they are roughly divided into several categories based on their fruit types, shapes and size.

On the other hand, pepper (*Capsicum sp*.), is one of the most varied and widely used foods in the world. There are a vast number of varieties of pepper and every variety is indicated with the original language and dialect of the local culture, which differs from town to town and from region to region. For these reasons the classification of peppers is not simple (IBPGR, 1983). Nigeria is known to be one of the major producers of pepper in the world accounting for about 50% of the African production (Business day, 2007). The pepper grown in Nigeria is in high demand because of its pungency and good flavour (Adigun, 2001).

Tomato and pepper fruits are now recognized as rich sources of antioxidants, in which vitamin A, C and lycopene are some of the most abundant antioxidants identified in them (Howard *et al*., 2000; Prasad *et al*., 2002; Marin *et al*. 2004). Since, the protective roles of dietary antioxidants can't be overemphasized against multiple diseases, such as, cancer, anemia, diabetics, cardiovascular diseases etc. These antioxidants perform their functions by counteracting the oxidizing activities of highly reactive oxygen species, thereby, preventing the oxidative modification of low density lipoprotein, nucleic acids, proteins etc (Oyewo *et al*., 2010). Therefore, there have been recent increases recorded in the demand in the consumption, particularly among the urban community. This is due to the increased awareness on the food value of vegetables (tomato and pepper), especially as antioxidants (Fisseha, 2002). The objective of this study, therefore, was to determine the concentration of vitamin A, C and lycopene in some varieties of locally available tomato and pepper in

Ogbomoso, south west region of Nigeria. This will better inform the populace in the environs on the varieties that are best for consumption.

2. Materials and Methods

2.1 Materials

2.1.1 Fruit Samples

Fresh samples of four tomato fruit varieties and six pepper varieties were purchased from three different market locations in Ogbomoso, Oyo State, Nigeria. The different varieties of tomato and pepper were identified at the Department of Crop Science, LAUTECH, Ogbomoso, as: plum tomato, marmande tomato, beefsteak tomato, cherry tomato, bell pepper, green pepper, cayenne pepper, sweet pepper, hot pepper and dry cayenne pepper.

2.1.2 Chemical Reagents

All the chemicals and reagents used in the study were of analytical grade and were purchased from the Bristish Drug House (BDH) Poole England and Sigma Aldrich Chemical Co. Inc., Milwaukee, Wis., U.S.A.

2.2 Methods

2.2.1 Preparation of Crude Fruit extracts

The soft and/ infested fruits were sorted out from the fresh tomato and pepper fruits and the good ones blended into smooth thick liquid paste in an electronic blender. The liquid pastes were stored refrigerated in air tight-labeled plastic bottles at 4^0C. The dry cayenne pepper was ground to fine powder using the same electronic blender and the powder was stored at room temperature in air tight plastic bottles.

2.2.2 Determination of Vitamin A and Lycopene Contents

The bottles containing the liquid pastes were removed from the refrigerator and allowed to attain room temperature. The concentrations of vitamin A and lycopene in the respective liquid pastes of the tomato and pepper fruits were determined by the method of AOAC (1990) as described briefly:

From the respective plastic bottles, 5 g of the paste was weighed into a conical flask and 12.5 ml of 0.5 N ethanolic KOH was added. The resulting solution was refluxed for 3 minutes and shook, using an orbital shaker for 10 minutes and 37.5 ml of petroleum spirit (ether) was added. The resulting solution was transferred into a separating funnel and the solution was washed with 25 ml of distilled water. Sodium sulphate was added to dry off the liquid and the upper layer (ether extract) was evaporated to dryness on an electric hot plate and the ether extract left to cool at room temperature. To recover the sample after drying, 10 ml of chloroform was added and the absorbance of the resulting solution was read at 520 nm (vitamin A) and 505 nm (lycopene) in an ultra violet-visible spectrophotometer. The content in the two layers in the separating funnel were thus:

Upper layer → petroleum ether layer: lycopene and vitamin A

Lower layer→ aqueous layer: water and other impurities

Calculations:

$$\text{Vitamin A } (\mu g/100g) = \frac{\text{Absorbance of sample x Dilution Factor}}{\text{Weight of sample (g)}}$$

$$\text{Lycopene } (mg/100g) = \frac{\text{Absorbance of sample X Gradient factor X Dilution Factor}}{\text{Weight of sample (g)}}$$

Conversions:

6µg of β-carotene = 1 retinol equivalent

12µg of other biologically active-carotenoids = 1 retinol equivalent

1 retinol equivalent of vitamin A activity = 1 µg of retinol

1 retinol equivalent = 31U (U = International Unit).

2.2.3 Determination of Vitamin C content

The concentration of vitamin C in the respective liquid pastes of the tomato and pepper fruits were determined by the method of Riemschneider *et al*. (1976) with some modofications, as described briefly:

Into 100 ml conical flask, 5g of the paste was weighed into 100 ml conical flask, 45ml of distilled water was added and the solution was shook thoroughly, using an orbital shaker for 60 minutes. The solution was filtered and the filtrate was stored at room temperature in air tight plastic bottles. Into a 25 ml conical flask, 2ml of indophenols solution was added and the solution was swirled for 2 minutes. The filtrate from the fruit paste above was transferred into a burette and titrated against the indophenols solution until a colour change from a deep blue to deep brown-light yellow was observed. The volumes of the filtrates consumed were recorded and the concentrations of vitamin C were calculated thus: $C_1V_1 = C_2V_2$

C_1 = concentration of indophenols

V_1 = volume of indophenols = 2ml

C_2 = concentration of Ascorbic acid

V_2= volume of standard ascorbic acid titrated against 2ml of indophenols

2.3 Statistical Analysis

The results were expressed as mean ± standard deviation of three determinations and student t test was performed to determine the significant mean values at 95% confidence level ($p<0.05$).

3.0 Results

Results were presented as mean ± standard deviation of three determinations and different superscripts on mean values denote significant differences ($p<0.05$). The result obtained in the concentration of vitamin A, C and lycopene in the extract of the different tomato fruits is presented in Table 1. The concentration of vitamin A were not changed significantly ($p>0.05$) in the Marmande and Beefsteak tomato fruits, while it was significantly increased ($p<0.05$) in Plum and Cherry, but unchanged ($p>0.05$) between the Plum and Cherry fruits. No significant changes were recorded in the vitamin C concentration in the different tomato fruits ($p>0.05$). However, the trend obtained in the lycopene concentrations in the tomato fruits was similar to that presented in the vitamin A concentrations, with the exception that the lycopene content increased significantly ($p<0.05$) between the Plum and Cherry fruits (Table 1).

In Table 2, the trend obtained in the concentrations of vitamin A, C and lycopene in the various pepper fruits is depicted. The trend presented in the vitamin A concentration in the various pepper fruits increased significantly ($p<0.05$) in the order: green pepper < sweet pepper = hot pepper < bell pepper < dry cayenne < cayenne. For the vitamin C concentration, no significant changes ($p>0.05$) were recorded in bell, sweet and dry cayenne pepper fruits, while significant increases ($p<0.05$) were presented in the green, hot and cayenne pepper fruits with no changes ($p>0.05$) among the latter pepper fruits (Table 2). Lycopene concentrations were unchanged ($p>0.05$) in the hot and dry Cayenne pepper fruits, while significant increases ($p<0.05$) were obtained in the order of green pepper < sweet pepper < bell pepper < cayenne pepper.

Table 1. Concentration of vitamin A, C and lycopene in the tomato fruits extract

	(Varieties)			
	Plum	Marmande	Beefsteak	Cherry
Vitamin A	0.88 ± 0.04^b	0.53 ± 0.04^a	0.59 ± 0.02^a	0.84 ± 0.09^b
Vitamin C	1.16 ± 0.07^a	1.26 ± 0.07^a	1.16 ± 0.07^a	1.26 ± 0.47^a
Lycopene	0.96 ± 0.23^b	0.63 ± 0.07^a	0.72 ± 0.15^a	1.76 ± 0.12^c

Values are means ± SD; n=3. Values bearing different alphabets are significantly different ($p<0.05$).

Table 2. Vitamin A, C and lycopene concentrations in the pepper extracts

		(Varieties)				
	W. Cayenne	Bell	Green	Sweet	Hot	D. Cayenne
Vit. A	16.68 ± 0.11^e	6.82 ± 0.45^c	0.50 ± 0.11^a	1.03 ± 0.05^b	0.964 ± 0.18^b	9.216 ± 0.65^d
Vit. C	1.71 ± 0.32^b	1.45 ± 0.25^a	1.61 ± 0.11^b	1.81 ± 0.07^b	1.45 ± 0.32^a	1.26 ± 0.25^a
Lyco.	16.16 ± 0.11^e	6.53 ± 0.27^d	3.06 ± 0.17^c	0.79 ± 0.06^a	0.71 ± 0.00^a	2.65 ± 0.11^b

Values are means ± SD; n=3. Values bearing different alphabets are significantly different ($p<0.05$). Key: W. Cayenne (wet cayenne), D. Cayenne (dry Cayenne)

4.0 Discussion

Dietary (exogenous) antioxidants have been reported for their protective roles against multiple diseases such as cancer, anemia, diabetics and cardiovascular diseases. They perform these functions by counteracting (scavenging) the oxidizing effects of free radicals generated in the body on nucleic acid and lipids. Kaur and Kapoor (2001) reported that the major exogenous antioxidants are vitamin C, E, flavonoids (phenolics), lycopene, β-carotene etc, and that plant food sources are the major sources of these invaluable substances. Therefore, the regular intake of vegetable foods is indispensable for attaining good health, fitness and the feeling of well–being. This present study clearly demonstrates the utility of some varieties of tomato (*Lycopersicon esculentum*) and pepper (*Capsicum sp*) in the south-west region of Nigeria, as food supplement that can help to boost the endogenous antioxidant status.

Tomato is an excellent source of many nutrients and secondary metaboplites, such as folate, potassium, vitamins C and E, flavonoids, polyphenols, chlorophyll, β-carotene and lycopene, which are important for human health (Wilcox *et al*., 2003). The result obtained in the vitamin A, C and lycopene contents in the various tomato species (Table 2) indicated that the cherry tomatoes had the highest antioxidant capabilities, followed by the plum tomatoes. However, marmande tomato (Yoruba tomato) is poor nutritionally in the anti-oxidative capabilities. Therefore, the consumption of these two species of tomatoes may have among others in the boost of the endogenous antioxidative status, which have been reported to reduce the risk and/ incidence of oxidative damages associated with oxidative stress. This is in agreement with the previous report that the consumption of fresh and processed tomato products are associated with reduced risk of cancers and heart diseases (Ames *et al*., 1993; Pandey *et al.*, 1995; Baysal *et al*., 2000; Devaraj, 2008).

Lycopene and vitamin A are carotenoid, which are natural pigments produced by plants and micro-organisms but not animals. Lycopene and vitamins A are closely related, but have divergent biological roles in mammals and are not inter-convertible (Lu *et al*., 2003). The majority of dietary lycopene has been shown to be obtained primarily through the consumption of tomatoes (Mackinnon *et al*., 2009). β carotene in tomatoes are reported to contribute to the overall vitamin A content.

Increase in the levels of dietary lycopene through the consumption of fresh tomatoes and the tomato products has been recommended by many health experts (Agarwal and Rao, 2000). The singlet oxygen quenching properties of lycopene and its ability to trap peroxyl radicals prevents the oxidation of low density lipoprotein-cholesterol and thus the reduction in the risk of developing atherosclerosis and coronary heart disease and other degenerative diseases (Levy *et al*., 1995; Agarwal and Rao, 2000). Vitamin C is a sugar acid with antioxidant properties. Ascorbic acid can terminate free radical chain reactions by serving as a stable (electron and proton) donor in interactions with free radicals. The oxidized forms of ascorbic acid are relatively unreactive and do not cause cellular damage, but are converted back to the reduced ascorbic acid by mammalian cellular enzymes.

Pepper fruits on the other hand are a rich source of antioxidants (Howard *et al*., 2000; Marin *et al*. 2004). They have high levels of vitamins C and E, as well as carotenoids (vitamin A and lycopene) and xanthophylls (Materska *et al*. 2003). In this study, the concentrations of lycopene, vitamin A and C obtained in the various pepper fruits (Table 2) were higher than those in the tomatoes species (Table 1). Even the dry cayenne pepper presented better anti-oxidant capabilities than virtually all the tomato species. The trend obtained in the lycopene and vitamin A contents in the green pepper variety was due to the lack of bright (red, yellow or pink) pigmentation. This is so because Clinton (1998), reported that vitamin A concentration in vegetables increases with increase in ripeness. However, of all the pepper varieties studied, cayenne pepper presented the highest anti-oxidant capabilities (Table 2).

5.0 Conclusion

The overall finding of this study indicated that the pepper varieties had better anti-oxidative capabilities, while marmande tomatoes had the least anti-oxidative capabilities. Therefore, for the best blend of ingredients for stew or soup making with high anti-oxidative capabilities, the cayenne pepper and plum tomatoes are recommended.

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